GEODESY AND MEASURES OF PRECISION

A Treatise on the Adjustment of Observations, with Applications to Geodetic Work and other Measures of Precision. By T. W. Wright, B.A., C.E., late Assistant Engineer United States Lake Survey. (New York: D. Van Nostrand, 1884.)

THIS treatise will be found a valuable addition to the literature of geodetic operations; the title is, however, misleading,—it implies a discussion of the various corrections required to allow for the effects of temperature, refraction, &c.; such corrections, however, are either omitted or only superficially dealt with, and the principal subject-matter is the adjustment of unavoidable errors by the method of least squares.

The work commences by a discussion of the various causes of error, and several practical hints are given as to how to diminish them. A remark in connection with personal error is worth quoting:—"A good observer, having taken all possible precautions with the adjustments of his instruments and knowing no reason for not doing good work, will feel a certain amount of indifference towards the results obtained. The man with a theory to substantiate is rarely a good observer, unless, indeed, he regards his theory as an enemy and not as a thing to be fondled and petted."

In the second chapter the usual law of error is stated, and the method of least squares is deduced therefrom, together with formulæ for calculating the mean square error, the probable error, and the average error. The author points out that the name "probable error" is unfortunate, and so we think; he is also of opinion that the average error might with advantage be more used than it is at present as a measure of the precision of a set of observations. This chapter is concluded by a most instructive discussion on the laws of error, based on various assumptions as regards the number of sources of unavoidable error. It is first supposed that there is only one source of error, and that all errors between certain limits are equally probable; the curve of error then becomes a finite straight line. The next case considers two independent sources of error, the curve then becomes two straight lines intersecting on the axis of y at an angle of 45°. In the third case three sources of error are assumed, and the curve of error is shown to consist of three parts, which together form a close approximation to the usual curve of error. The method of least squares is further developed in the succeeding three chapters, and applied to the adjustment of the direct observations of one unknown, to indirect and to condition observations. Various methods of solving the numerous resulting equations are given, both rigorous and approximate; amongst the latter the method of solution by successive approximations as used in reducing the primary triangulation of the Ordnance Survey of Great Britain is strongly recommended. The author also recommends the use of a calculating machine, or of Crelle's Tables, in order to diminish the arithmetical labour.

The remainder of the work is devoted to applying the foregoing to triangulation, to base-line measurements, to spirit levelling, to trigonometrical levelling, to the graduation of line measures, to the calibration of thermometers, and to the discovery of empirical formulæ. The application to triangulation is treated very fully, and several methods of solving the necessary equations are given and exemplified by means of examples. One of these examples is the adjustment of the angles of a quadrilateral taken from the Survey of the Great Lakes of North America, executed by the United States engineers; three methods of solution are given, one of them being that adopted by the United States engineers.

The author remarks very truly that it is a waste of time applying the rigid methods of adjustment to tertiary or even to secondary triangulation, and he proposes a method of successive approximations by first adjusting the angles at each station for the local conditions, and then using these adjusted values for the further adjustment in connection with the side and angle equations of the net. It may be mentioned that the reduction of the secondary triangulation of Great Britain, now being carried out, is effected by a graphic method applied after the angles have been locally adjusted; this method is found to give excellent results with far less labour than even an approximate method of calculation. The criticism on the title of the work is well exemplified in the chapters on base-line measurements and on the graduation of line measurements. For instance, there is no mention of the corrections required to be made to a base-line measurement to allow for errors in alignment or of level, for the effects of temperature and for reduction to sea-level. We think that at any rate a sketch of these and other sources of error and their methods of adjustment would not have been amiss.

The adjustment of the errors of trigonometrical levelling is very fully considered, and one of the examples proposed for solution is the adjustment of the levels taken trigonometrically during the triangulation executed to determine the axis of the St. Gothard tunnel.

The following remark is, we think, worth quoting:—"Closely allied to the preceding (elimination of accidental errors) is the common idea that if we have a poor set of observations good results can be derived from them according to the method of least squares, or that if work has been coarsely done such an adjustment will bring out results of a higher grade. A seeming accuracy is obtained in this way, but it is a very misleading one. The method of least squares is no philosopher's stone; it has no power to evolve reliable results from inferior work."

An excellent feature in the work is the illustration of the text by means of examples, embracing almost every possible case that occurs in practice. Some of these examples are fully worked out, others are proposed as exercises. Most of them are derived from geodetic work carried out in the United States. In conclusion we can strongly recommend this book.

OUR BOOK SHELF

On the Higher Teaching of Agriculture. By the Rev. J. B. McClellan, M.A. (Edinburgh: T. and A. Constable, 1884.)

NOT the least among the benefits of the International Health Exhibition was the series of Conferences held in connection therewith; and of these, one of the most valuable was the Conference on Education held in August last. Dr. Armstrong's paper on science-teaching in

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schools has been already noticed in NATURE (vol. xxxi. p. 19), and the paper before us, by the Principal of the Royal Agricultural College, Cirencester, is another product of the Conferences. The author looks on agriculture broadly, as extending, like the theme of the poet of the "Georgics,"—

> " . . . super arvorum cultu per corumque
> Et super arboribus,"

and in a well-reasoned and well-written paper pleads for the teaching of the natural sciences, their facts, laws, methods, and applications to agriculture, to those who have the direction of agriculture in this country, or who seek fortunes in the soils of new countries. Cowley, two centuries ago, asked, "Who is there among our gentry that does not entertain a dancing-master for his children as soon as they can walk? But did ever any father provide a tutor for his son to instruct him betimes in the nature and improvements of that land which he intended to leave him?" Though this reproach is not deserved so much now as when it was written, it is still not wholly unmerited, and will so remain until those who have the possession and management of landed property shall receive some special training such as that sketched out by Mr. McClellan. This training, if fairly common, would do far more to mitigate agricultural depression than any amount of piecemeal legislation. The paper is a useful addendum to Mr. Jenkins's recent report on agricultural education, and it may be commended to the attention of landowners and others connected with agriculture.

The Text of Euclid's Geometry. Book I., uniformly and systematically arranged. With a discussion of Euclid's application of logical principles, copious notes, exercises, and a figure-book. By J. Dallin Paul, R.N. (Cambridge: Deighton, Bell, and Co., 1884.)

THIS is a "prodigious" work of 182 pages demy 8vo, printed on excellent paper, with clearly-drawn figures, devoted to the "painful" elucidation of all the difficulties to be found in the first book of Euclid's Geometry, with such other matter as hath been adumbrated in the above-cited title-page. The road may be an easy one to walk in, all stones of offence being carefully put on one side or so rearranged that the wayfarer may not stumble as he saunters along it, but it certainly is a long road. The tendency of modern agitation a few years ago was to condense our text-books with a view to get up geometry in the minimum of time, but experience has taught us that in the majority of cases junior boys are very tender-footed, and cannot be driven along the geometrical path, and so there has been a reversion to the "grand old" book with many an aid to lure the young into paths not naturally attractive to them. We do not find fault with these attempts—we have recently noticed in these columns two admirable editions of the "Elements,"—but Mr. Paul has taken, we think, an extreme course: at some perhaps not distant date, if this sort of editing is catching, we shall have a similarly got-up work devoted to Euclid's treatment of isosceles triangles with a preliminary chapter on an axiom.

Our author has had so much to do with Euclid that his views of life have possibly got to be Euclid-tinted, and he sees nothing but Euclid! It would be no wonder, for his own words are, in deprecation of the presumption of adding another edition to the many that have gone before, "having been teaching Euclid almost daily for the last twenty years to pupils who, before coming under his tuition, had learnt something of geometry from the different text-books in use during that time, he ventures to think that this experience has made manifest to him the principal advantages and disadvantages of these numerous works, and thereby enabled him to present the propositions in the form most likely to be of educational value to those who are beginning either to learn or to teach the subject." We have allowed the author to put so much in evidence that the majority of our readers may gather that this is not "just the book they wanted" for themselves, and yet may see the scope of Mr. Paul's labours.

We cannot commend the author's action in placing the notes on the propositions in the early part of the book; experience has shown him that when placed in their usual position at the end they are passed by, but their actual position here offends *our* eye, and will not, we fancy, secure the writer's object. We regret that the writer has spent so much time and thought to so little purpose, as we believe, for we cannot imagine who will be the public that will purchase his book, its size and price are a bar to its introduction into school use. We close with remarking that there is a good deal that may be of use to (say) a pupil-teacher, or to one who is not strong in geometry and yet has to teach young pupils; but much, if not all, of this, can be got in handier text-books. A good feature is the placing at the end the particular enunciations of the propositions with the diagrams placed in positions very different from those which they had in the text: this would enable a pupil to test his acquaintance with the subject. R. T.

Das kleine botanische Practicum für Anfänger. Von Dr. Eduard Strasburger. Mit 114 Holzschnitten. (Jena, 1884.)

A BOOK by Prof. Strasburger, entitled "Das botanische Practicum," has recently been reviewed in NATURE, and recognised as a most valuable addition to botanical literature. The same author has now produced a condensed edition of the same book under the heading given above. The more important of the facts distributed through the 600 pages of the first and larger edition are here collected into the smaller space of 250 pages, an arrangement which is obviously better suited to beginners. It was specially remarked in the review of the larger edition that the efficient study of the various types named would occupy the average student a longer time than the author of the book appeared to think. This smaller edition will obviate the difficulty by supplying the elementary student with a shorter course of study, while the larger book will no doubt be found more useful as a book of reference for more advanced students, or as providing a curriculum for those who will make botany their profession. The merits of good type and excellent illustrations are to be found in this smaller book in as high a degree as in the earlier and larger edition. F. O. B.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Dr. Koch and the Comma-Bacterium

THE article published in NATURE of December 4, setting forth Dr. Koch's well-known theories with regard to the connection of a comma-shaped micro-organism with cholera, serves very efficiently as the text for one who desires to point out the deficiencies in Dr. Koch's observations and reasonings on this subject. The article is the most favourable statement which can be made on the side of those who accept Dr. Koch's conclusions, and is to a certain extent not quite fair to his opponents, since his original statements are not clearly separated from the subsequent statements which he has made in reply to criticisms.

In opposing Dr. Koch's conclusions, it is desirable at the very first to state clearly that those who accept them appear to labour under two important misconceptions, the first being that Dr. Koch is, and has been for a long time, acquainted with *every* form (and the complete history of every form) of Schizomycetes or Bacteria existing, whether in the healthy body or in disease,

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